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ABSTRACT

The purpose of the present longitudinal study was to determine how well a broad, comprehensive battery of tests administered in kindergarten predicts reading achievement in elementary school grades 1 through 6. The test variables were reduced to six predictive factors by factor analysis, and these, together with the variables, Child's Sex and Parent's Language, had multiple correlations with reading achievement of .58 (grade 1), .65 (grade 2), .70 (grade 3), and .66 (grade 6). Path analysis showed that there was a direct effect of the predictor variables mainly on grade 1 reading, and that their effect on later reading was indirect. For economy of time and resources, it was found possible to use a preliminary screener, and still retain almost all the predictive accuracy of the full battery. (Author)

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A Seven Year Longitudinal Study of Early Prediction of Reading Achievement

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Running Head: A seven year longitudinal

Abstract

The purpose of the present longitudinal study was to determine how well a broad, comprehensive battery of tests administered in kindergarten predicts reading achievement in elementary school grades 1 through 6. The test variables were reduced to six predictive factors by factor analysis, and these, together with the variables Child's Sex and Parent's Language, had multiple correlations with reading achievement of .58 (grade 1), .65 (grade 2), .70 (grade 3), and .66 (grade 6). Path analysis showed that there was a direct effect of the predictor variables mainly on grade 1 reading, and that their effect on later reading was indirect. For economy of time and resources, it was found possible to use a preliminary screener, and still retain almost all the predictive accuracy of the full battery.

A seven year longitudinal study of early prediction of reading achievement

Children with severe reading problems which are not diagnosed and treated at an early age are likely to develop learning disabilities. Unless remediation is instituted at an early stage, the gap between the disabled and his or her peers may continue to widen. The incidence of such disabilities reported varies between 7% and 15% depending upon the criterion.

The need for an efficient and accurate means of predicting academic failure at an early age has been raised by many studies (Book, 1975; Butler, 1979; de Hirsch, Jansky, & Langford, 1966; Feshbach, Adelman, & Fuller, 1977; Pope, Lehrer, & Stevens, 1980; Satz & Friel, 1974; Sheppard et al., 1979; Sheppard & Sheppard, 1983). The present study explores the predictive ability of a wide battery of tests over an extensive longitudinal span of seven years. There is a need for studies which can track children longer than one or two years, as it is possible that predictability may not be sustained with time. If there is continued substantial predictability over a period such as seven years, one may conclude that the predictors have some robustness, and the predictive power is enhanced.

One study which examined longitudinal changes was that of Feshbach et al. (1977), though it was for a shorter span than seven years. They administered three scales as predictors to two samples (N = 888, N = 844) in kindergarten, and reading criterion measures at grades 1, 2, and 3. Correlations generally between .4 and .5 were obtained between predictors and the criterion measures. At grade 3 those remaining in the sample N = 888 were administered the Co-operative Primary Reading Tests as criterion tests. On the Student Rating Scale, a predictor administered in kindergarten, there were 44 children identified as having a high risk of reading difficulty, and 407 with a low risk. On criterion test scores, 406 were correctly classified, i.e., 90%. Attrition was from 888 to 451 subjects. On the de Hirsch-Jansky Predictive Index, another predictor given in kindergarten, there were 42 high risk, 389 low risk, with 366 correctly classified, i.e., 85%. Attrition was from 888 to 431. For children who were available for testing at all of the criterion test administrations in grades 1, 2, and 3 (N = 403), the correlations between the criterion and the Student Rating Scale were .43 (grade 1), .48 (grade 2), and .44 (grade 3). When IQ was controlled and partialled out the correlations were reduced but still remained significant (e.g., grade 3, r = .33). Predictability was not only sustained with time, but actually increased beyond the grade 1 level of predictability.

Few studies are reported with a span of about seven years. Pope et al. (1980) used a battery of four tests to validate a diagnostic screening method for identifying kindergarten pupils who could be predicted to have reading difficulties five years later. The tests were the Wide Range Achievement Test (WRAT), a Teacher Check List (TC), the Slosson Intelligence Test (SIT), and the Meeting Street School Screening Test (MSSST). A criterion measure, the Woodcock Reading Mastery Test (WRMT) was administered in grade 5. The battery was given to 267 girls and 278 boys in kindergarten, and a correlation was obtained of .50 between the reading subtest on the WRAT and the reading criterion test WRMT five years later. There were 46 children identified at kindergarten as having a high risk of subsequent reading difficulties, with 105 low risk. Of these, 125 were shown by the WRMT at grade 5 to have been correctly classified, i.e., 83%. Only children who remained at the one school where the study was conducted were included in the data analysis. Attrition rates were not reported. Another weakness in the study was the use of only the extreme groups (high risk and low risk) for calculating the correlation coefficient rather than basing it on the full range of scores one would obtain by testing all the sample of 545 children (minus attrition).

Satz and his associates (Satz, Friel, & Rudegeair, 1976; Satz & Morris, 1980; Satz, Taylor, Friel, & Fletcher, 1978) have also tracked children on a longitudinal basis, using a wide battery of predictors at kindergarten (N=497) and testing reading at grades 1 - 5. Interestingly, they found that the predictive accuracy did not attenuate as the test-criterion interval increased, despite the increase in uncontrolled environmental, growth, learning, and experiential factors that such a time interval might be expected to produce. Satz et al. (1978) did not provide correlation coefficients for the relation-

ship between predictors and criterion reading measures, but did provide hit rates. At grade 5, dividing the sample into high risk and low risk, 318 were correctly classified, i.e. 72%.

Satz (1977) has emphasized the need for longitudinal studies in this area. He sees them as absolutely essential for moving to explanations of second-order relevance. Basic research is needed on large samples followed for longer time periods than usual, if intervention programs are to be applied appropriately. There is a need to avoid misclassification of children, such as those who are wrongly regarded as high risk, yet become satisfactory readers in later years without special intervention. Long-term longitudinal studies can bring to light the degree to which predictive accuracy may attenuate with increased time-span. The present study was developed with such an objective in mind.

The present study sought to locate those children at high risk of developing reading difficulties, assessing the effectiveness of a wide range of predictor tests administered early in the child's schooling. Several hundred children were tested in kindergarten on a broad comprehensive battery, then monitored for reading achievement at grades 1, 2, 3, and 6. The primary objective was to evaluate how well reading achievement could be predicted over a long time span. Specific issues included: (a) Do the tests predict reading achievement beyond that which could be explained by IQ alone? (b) Does the level of predictability in the four grades differ? (c) Does the impact of the different predictors vary in the four grades? (d) Can the use of a preliminary screening device substantially reduce the amount of testing which needs to be done without sacrificing the ability to detect children with reading problems?

Method

Subjects

At the start of the study in 1974, the sample consisted of a total of 392 kindergarten children (204 boys and 188 girls), average age being 5 years 7 months, with ages ranging from 5 years to 7 years 2 months. They were drawn from seven schools in the St. George district of metropolitan Sydney, an area chosen because it was representative of the diversity of socioeconomic levels and cultural backgrounds often found in the state of New South Wales. English was spoken in the home by at least one parent in the case of 78% of the subjects. The largest non-English speaking group was Greek migrants. The population is described in greater detail elsewhere (Butler, 1979).

A pretest battery of potential predictors of reading was administered to the children in 1974 (kindergarten), and a number of reading tests in 1975 (grade 1), 1976 (grade 2), 1977 (grade 3), and 1980 (grade 6). The children were thus tracked over a 7-year period. Many children changed to another metropolitan school district or moved out of the city. When these children could be located, materials were sent to their teacher, requesting co-operation, and a special visit was made to the school by research project staff to test the child. The eventual attrition that did occur was the result mainly of children moving interstate or out of the country, or leaving no forwarding address.

Materials & Administration

Tests administered over the 7-year period of the study are listed in Table 1, together with the demographic variables. They are part of a larger, continuing project described by Butler (1979), and Butler, Marsh, Sheppard, and Sheppard (1982, Note 1, Note 2).

Insert Table 1 about here

Statistical Analysis

Preliminary Data Reduction. To produce a more manageable set of variables, preliminary analyses were carried out to combine variables, mainly by factor analysis. Factor analysis of the set of predictor variables resulted in six predictor factors which are described in Table 2. Four additional measures were collected while the children were in kindergarten, but were not included in the factor analysis. Two of these were IQ measures, the Peabody and the Slosson (see Table 1), which were combined to form a single IQ measure. The other two were the child's sex, and a dichotomously scored variable indicating whether at least one of the child's parents spoke English. While these variables were not included in the factor analysis of other kindergarten measures, their relationship with the predictor factors and subsequent reading measures is examined in this study.

Insert Table 2 about here

A total of 28 reading scores, including subscale scores from the Stanford and the Doren tests, were collected in grades 1, 2, 3, and 6. Separate factor analyses were performed on the reading scores collected at each grade level. These analyses demonstrated that a single factor adequately summarized the measures for each year: in each analysis the first factor accounted for about two-thirds of the variance; none of the analyses resulted in more than one eigenvalue greater than 1.0; and none of the analyses produced more than one factor which could be readily interpreted (see Butler, Marsh, Sheppard, & Sheppard, Note 1, Note 2, for further discussion). Even when all 28 reading scores were included in the same factor analysis, the variables were reasonably well

summarized by a single factor. Consequently, reading scores for each year and a combined score across all four years were represented by factor scores produced by the SPSS factor analysis procedure (see Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975)

Missing Values. Despite a concerted effort to trace children who moved from the school district, only 320 (of 392) children could be located in 1977, and 286 in 1980. The 106 children who were tested in kindergarten but could not be located in 1980 did not differ significantly from the other children on scores from the Slosson and Peabody tests which were administered to all children in kindergarten. Similarly, the 1977 reading score for the 34 children who could not be located in 1980 did not differ significantly from the other 286 children. Thus, while the problem of attrition does dictate caution in the interpretation of the results, it seems unlikely that such a problem has any substantial influence on the conclusion of the study.

Analyses described in this study are based upon the 320 children tested in 1977. For this sample there were virtually no missing values for any variable collected in 1977 or earlier. Factor scores used to represent the predictor factors, the IQ measure, reading scores at each of the four grade levels, and the combined reading measure were determined such that weighted factor scores were produced for cases with missing values (see Nie et al., 1975). Thus for these summary scores, except for the 1980 reading score, there were no missing values (for the 1980 reading score the 34 children who were not tested at all were given missing values).

Subsequent Analyses. Subsequent analyses are based upon relationships among the eight predictor variables (Sex, Parent's Language, and the six predictor factors), the five criterion variables (reading scores for grades

1, 2, 3, and 6, and the combined reading score), and the one control variable (the combined IQ measure). In the first analysis simple correlations were determined and then the effect of IQ was partialled out of each relationship. Next, multiple regression was used to determine how well the criterion measures could be predicted by the predictor variables, and a path analytic model was developed to describe these relationships. The correlational analyses were conducted with pair-wise deletion of missing data (Nie et al., 1975). However, results based upon only the 286 (of 320) cases where there were no missing values for these variables were nearly indistinguishable from those described in this study. Finally, the effectiveness of using a preliminary screening device in conjunction with a comprehensive battery of tests was explored.

Results

Intercorrelations between predictor and criterion variables

Relationships were examined between the eight predictor variables (the six factors, sex, and parent's language), the four criterion variables (reading scores for grades 1, 2, 3, and 6 in actual and predicted form), and the control variable (IQ). Simple Pearson product moment correlation coefficients were calculated between the variables, then the effect of IQ was partialled out for each one. Table 3 presents these relationships, together with the correlations between IQ and each other variable.

Insert Table 3 about here

It can be seen that there is a small relationship between sex and reading performance at the four grade levels. Girls tend to have obtained higher reading scores than boys, and partialling out IQ did not make much difference to this finding. The second background variable, parent's language, also

showed a relationship with reading performance but in this case the partialling out of IQ brought the correlations close to zero. However, this result must be interpreted very cautiously since the IQ tests require a high component of English understanding and no attempt was made to test children in their native language.

The six predictor factors are each correlated significantly with the reading scores in the four grades, generally with a coefficient of about .4 or .5. The size of the correlations is reduced by partialling out IQ (generally to about .3), but not markedly, and the coefficients remain significant. The predictive factors are able to predict substantial portions of the variance in reading beyond that which can be accounted for by IQ alone. They are also more successful predictors of reading than are the background variables.

Multiple Regression Analysis

To assess how well each of the criterion variables (reading scores at each grade level and the combined reading score) could be predicted by the set of eight predictor variables, stepwise multiple regression analyses (Nie et al., 1975) were performed, yielding the finding that predictable portions of the variance in the reading scores was 34% for grade 1, 42% for grade 2, 49% for grade 3, 44% for grade 6, and 50% for a combined reading score based upon measures from all four years. Table 4 provides the order by which the variables were entered into the regression equation, the degree of change in correlation as they are entered, and final beta weights. Inspection reveals that only one variable did not enter significantly into any regression equations, the fifth factor, Perceptual Motor. The background variables, sex and parent's language, contributed little beyond what could be explained by the predictor factors. The most important variables were Factors III (Language), I (Psycho-

linguistic Abilities), VI (Spatial/Form Perception), and II (Figure Drawing). Factor IV (Rhythm) also entered significantly into all but one of the regression equations.

Insert Table 4 about here

It is particularly interesting to note that the predictability of reading scores in this study improves substantially between grades 1 and 3, and drops off only slightly in grade 6. Measures collected in kindergarten do a better job of predicting reading scores in sixth and third grade than in second, and better in second grade than in first. Furthermore, with a few minor exceptions, this pattern holds for each of the predictor variables (see Table 2). This pattern is in marked contrast to most validity studies where the longer the time interval between the collection of predictor and criterion variables, the poorer the prediction. The apparent explanation for this phenomenon is with the measurement of reading. The predicted reading scores, as opposed to the actual reading scores, for each of the four grades all correlate .96 or higher with each other. Consequently, the predictor variables predict virtually the same relative performance in each of the four grades. This suggests that the criterion is becoming more predictable rather than the predictors doing a better job of predicting, and perhaps the explanation lies in our ability to measure reading in the first grade. There is also the possibility that the particular selection of reading tests used in the present study is responsible for this finding. However, similar phenomena were reported by Clark, Bruininks, & Glaman (1978) and Feshbach et al. (1977).

Path Analysis

Path analysis was used to further examine the relationships between

predictor and criterion variables, and to decompose correlations into direct, indirect, and spurious effects (see Wolfle, 1980 for further discussion). The rationale for the path model in Figure 1 and its analysis is presented in more detail by Butler et al. (1982). The two background variables, sex and parent's language, have little direct effect on any of the reading measures. Sex has a direct effect on reading at grade 2, represented by the straight arrow connecting the two variables and the path coefficient, but has no indirect effect through any of the predictor variables. Parent's language has no direct effect on any of the reading scores, but an indirect effect through the predictor factors.

The predictor factors have large direct effects on reading in grade 1, but their subsequent effect on later reading is primarily indirect through their effect on first grade reading. After first grade, the largest direct effect on the reading measures is the reading score from the preceding grade level. This finding is important and argues that most of the impact of characteristics measured by the predictor variables occurs in first grade. Reading in subsequent grades can be explained in terms of early reading achievement without reference to the characteristics measured by the kindergarten scores. The relative level of reading achievement demonstrated by students early in their school career remains remarkably consistent across all six elementary school years.

Expectancy Tables For Alternative Screening Strategies

Expectancy tables were constructed to assess the degree to which predictor variables were effective in identifying poor readers as defined by the combined reading measure (reading scores combined over all four grades). The hit rate used to summarize these tables will vary depending upon the number of children designated to be poor readers and the number

predicted to be poor readers on the basis of the kindergarten measures. The optimal values will depend upon the application, and the costs involved in false positive and false negative decisions. For example, the 10% of the sample (32 children) actually scoring the lowest on the reading criterion were designated to be poor readers, and the 10% of the sample predicted to score lowest were determined. Here, 18 of the 32 poor readers were correctly identified, as were 274 of 288 children who were not poor readers. This results in a hit rate of 91% (18 + 274 ÷ 320). However, as shown in Table 5 (Strategy I), these results will vary for different criteria of poor readers.

Insert Table 5 about here

Findings described thus far are based upon the entire battery of predictor variables, but the use of a preliminary screening test may be more cost effective while still retaining most of the predictive power of the total battery. Thus, all children might be tested with a preliminary screening measure, but only those scoring below some minimal value would be tested with the more extensive battery of tests. This approach was assessed with two different screening tests: the Letter Recognition Test (LRT) and the Sheppard School Entry Screening Test (SSEST). The LRT is easily administered by a classroom teacher and correlated more highly with the combined reading score than any other single variable in the test battery ($r = .57$ vs. Mult $R = .71$ for the set of predictor variables). The SSEST, though more extensive and time consuming, is also designed to be administered by a classroom teacher. Previous research (Butler et al., 1982) with data from this study demonstrated that the SSEST measures three factors, and in the present study these combine to correlate Mult $R = .60$ with the reading criterion.

With strategy II, based upon the LRT, children scoring in the top half of the LRT were automatically classified not to be poor readers, regardless of their scores on the other predictor variables. This is equivalent to not testing them with the more extensive battery of tests. The classification of the rest of the children applied the same cut-off values, based upon all the predictor variables, as employed with strategy I. Similarly, for strategy III, children scoring in the top three-quarters of the SSEST were classified not to be poor readers and other predictor variables were only used to classify the remaining 25% of the children. In each instance, the ability to predict children who are poor readers is nearly as good as with strategy I (see Table 5). These findings demonstrate the potential value of using a two-stage classification scheme where a preliminary device is used to exclude children who are unlikely to have problems in reading and a more extensive battery of tests is administered to the rest of the children.

Discussion

Children in the present study were tracked over seven years of schooling in a longitudinal analysis that showed predictors given in kindergarten could correlate, with a multiple correlation coefficient, .66 with reading achievement six years later. This level or predictability, over such an extensive period, can be seen as high. The multiple correlation coefficient was even higher at grade 3 (Mult R=.70). Although a wide range of tests were administered in kindergarten, it was possible to reduce these to quite a manageable set of six factors, with two background variables, child's sex and parent's language. All these predictors were found to correlate significantly with reading scores, although the background variables had a smaller relationship with reading than did the factors.

Longitudinal studies which span several years allow researchers to examine how the accuracy of predictors changes over time. Paradoxically, in the present study measures collected in kindergarten were better able to predict reading performance in grades 3 and 6 than in grades 1 and 2. The explanation of this paradox seems to lie in our improved ability to measure reading in the later grades, rather than any increased relevance of the predictor variables. This has important implications for other research which examines predictive ability of measures over a shorter period of time.

Using a 10% criterion for children "at risk", a hit rate of 91% was found with the reading scores combined over grades 1, 2, 3, and 6, and a similar result was obtained for grade 6 alone. Pope et al. (1980) in their 6-year study, using their reading criteria at grade 5, had 40 out of 46 children identified correctly as high risk for reading problems, and 85 out of 105 identified correctly as low risk, making a hit rate of 83% (40 + 85 ÷ 151). Satz et al. (1978) in their 6-year study had 77 out of 90 identified correctly at grade 5 as high risk, and 241 out of 329 identified correctly as low risk, making a hit rate of 72% (77 + 241 ÷ 442). The present rate therefore compared favourably with other research in the area.

Characteristics measured in kindergarten had direct effects on reading in grade 1 which were large and substantial. However, their direct effects on reading in subsequent grades were weak or negligible. Instead, reading at each subsequent grade level was primarily a direct function of reading achievement at the preceding grade level. Thus a developmental process of the acquisition of reading skills is supported. This has important implications for early intervention programs. The findings suggest that early deficits, if remedied soon enough, will not have detrimental effects on later reading performance. Performance levels achieved in early grades appear to be remarkably stable during the six elementary school years.

Findings were based on the use of the full test battery. However, if the goal was to identify children at risk who may be given special attention, then a more economical testing procedure was shown to be practical. It was found that using one of two different components of the test battery, either 50% or 75% of the sample can be excluded from detailed comprehensive testing which may follow preliminary screening, with little loss in the ability to identify those children with reading difficulties.

To summarize, then, it has been found that kindergarten testing with a broad comprehensive test battery can lead to effective prediction of reading achievement over a seven year span at grades 1, 2, 3, and 6. The predictive accuracy increases with time, with only a minimal fall-off at grade 6. However, path analysis shows that the skills measured by the predictors are directly related to earlier reading, and this earlier reading directly impacts later reading. When seeking economy of scale, it is possible to use a fractional component of the battery effectively to identify those children with potential reading problems, and not lose more than a minimal amount of predictive accuracy.

Reference Notes

1. Butler, S. R., Marsh, H. W., Sheppard, M. J., & Sheppard, J. L. Screening for potential reading disabilities in the early years. Paper presented at the annual congress of the Australian and New Zealand Society for the Advancement of Science, Sydney, May 1982.

2. Butler, S. R., Marsh, H. W., Sheppard, M. J., & Sheppard, J. L. Predicting reading achievement from kindergarten to third grade - implications for screening. Unpublished manuscript, The University of Sydney, 1983.

References

Australian Council for Educational Research. Lower Grades Reading Test (Level 1 Group Test). Hawthorne: ACER, 1973.

Baker, H.J., & Leland, B. Detroit Test of Learning Aptitude. Indiana: Bobbs-Merrill Company, 1967.

Book, R.M. Predicting reading failure: a screening battery for kindergarten children. Journal of Learning Disabilities, 1975, 7, 52-56.

Butler, S.R. Predictive antecedents of reading disability in the early years of schooling. British Columbia Journal of Special Education, 1979, 3, 264-274.

Butler, S.R., Marsh, H.W., Sheppard, M.J., & Sheppard , J.L. Early prediction of reading achievement with the Sheppard School Entry Screening Test: A four-year longitudinal study. Journal of Educational Psychology, 1982, 74, 280-290.

Clark, C.R., Bruininks, R.H., & Glaman, G.V. Kindergarten predictors of three aspects of reading achievement. Perceptual and Motor Skills, 1978, 46, 411-419.

Daniels, J.C., & Diack, H. The Standard Test of Reading Skill (Test No. 1 Individual Test). London: Chatto and Windus Ltd., 1958.

de Hirsch, K., Jansky, J.J., & Langford, W.S. Predicting Reading Failure. A Preliminary Study. New York: Harper & Row, 1966.

Department of Health (New South Wales). Bureau Auditory Comprehension Test.

Doren, M. Doren Diagnostic Reading Test of Word Recognition. Minnesota: American Guidance Service, Inc., 1973.

Dunn, L.M. Peabody Picture Vocabulary Test. American Guidance Service, 1959.

Feshbach, S., Adelman, H., & Fuller, W. Prediction of reading and related academic problems. Journal of Educational Psychology, 1977, 69, 299-308.

Frostig, M. Developmental Test of Visual Perception. California: Consulting Psychologists Press, 1963.

Karlson, B., Madden, R., & Gardner, E.F. Stanford Diagnostic Reading Test. New York: Harcourt, Brace and World, 1966.

Kirk, S.A., McCarthy, J.J., & Kirk, W. The Illinois Test of Psycholinguistic Abilities. Urbana, Illinois: Institute for Research in Exceptional Children, 1961.

Nie, N. H., Hull, C.H., Jenkins, J.C., Steinbrenner, K., & Bent, D.H. Statistical Package for the Social Sciences. New York: McGraw Hill, 1975.

Pope, J., Lehrer, B., & Stevens, J. A multiphasic reading screening procedure. Journal of Learning Disabilities, 1980, 13, 98-102.

Reed, M. Picture Screening Test of Hearing. London: Royal National Institute for the Deaf, 1960.

Santucci, H. Epreuve Graphique D'Organisation Perceptive Pour Enfants de 4 à 6 ans. In R. Zazzo (Ed.), Manuel Pour l'Examen Psychologique de l'Enfant. Neuchatel, Suisse: Delachaux et Niestlé, 1964.

Satz, P. Reading problems in perspective. In W. Otto, N.A. Peters and C.W. Peters (Eds.), Reading Problems: A Multidisciplinary Perspective. Reading, Mass.: Addison-Welsley, 1977.

Satz, P., & Friel, J. Some predictive antecedents of specific reading disability: A preliminary two-year follow-up. Journal of Learning Disabilities, 1974, 7, 7.

Satz, P., Friel, J., & Rudegeair, J. Some predictive antecedents of specific reading disability: A two-, three-, and four-year follow-up. In J. Guthrie (Ed.), Aspects of Reading Acquisition. Baltimore: Johns Hopkins University Press, 1976.

Satz, P., Taylor, H.G., Friel, J., & Fletcher, J. Some developmental and predictive precursors of reading disabilities: A six year follow-up. In A.L. Benton and D. Pearl (Eds.), Dyslexia. An Appraisal of Current Knowledge. New York: Oxford University Press, 1978.

Satz, P., & Morris, R. The search for subtype classification in learning disabled children. In R.E. Tarter (Ed.), The child at risk. New York: Oxford University Press, 1980.

Schonell, F.J., & Schonell, F.E. Schonell Reading Test. London: Oliver and Boyd, 1955.

Sheppard, J.L., & Sheppard, M.J. Spotlight screener as a predictor of first-grade reading achievement. Australian Journal of Education, 1983, 27, 164-172.

Sheppard, M.J. A Teacher's School Entry Screening Test. Sydney: Robert Burton Printers, 3rd Edn., 1975.

Sheppard, M., Giergerl, B., Ireland, L., Lupton, P., Philps, C., Platt, R., Polly, J., Starr, J., & Turbill, J. Spotlight for Literacy. Early Reading Screener. Test Manual. Melbourne: Longman Cheshire, 1979.

Slosson, R.L. Slosson Intelligence Test. Slosson Educational Publications, Inc., 1963.

Stambak, M. Trois Epreuves de Rhythme. In R. Zazzo (Ed.), Manual Pour l'Examen Psychologique de l'Enfant. Neuchatel, Suisse: Delachaux et Niestlé, 1964.

Wolfle, L.M. Strategies of path analysis. American Educational Research Journal, 1980, 12, 183-209.

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Footnote

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Table 1

Predictor and reading criterion tests administered in 1974, 1975, 1976, 1977, and 1980, together with demographic and control variables

Kindergarten data collection 1974 November/December

Predictor Test Battery

Hilda Santucci Copying Geometric Forms Test (Santucci, 1964).

Marianne Frostig Developmental Test of Visual Perception (Shortened Form) (Frostig, 1963).

Letter Recognition Test

Auditory Attention Span for Related Syllables (Baker, & Leland, 1967).

Picture Screening Test of Hearing (Reed, 1960).

Mira Stambak Rhythm Test (Stambak, 1964). Test B (2) (Reproduction of Rhythmical Structures)

The Bureau Auditory Comprehension Test (Department of Health N.S.W.)

Illinois Test of Psycholinguistic Abilities (Kirk, McCarthy, Kirk, 1961).
A. Grammatic Closure B. Auditory Closure C. Sound Blending

A Teacher's School Entry Screening Test (Sheppard, 1975).

IQ tests, Control Variables

Peabody Picture Vocabulary Test (Dunn, 1959)

Slosson Intelligence Test (Slosson, 1963).

Demographic Variables

Sex

Parent's Language

Reading criterion tests 1975, 1976, 1977, 1980

1975 November/December. Grade 1

Australian Council for Educational Research Lower Grades Reading Test (Level I Group Test), 1973.

Daniels and Diack, Standard Test of Reading Skill (Daniels, & Diack 1958) (Test No. 1 Individual Test).

Schonell Graded Word Reading Test (R.I.) (Individual Test) (Schonell, & Schonell, 1955).

1976 October/November/December. Grade 2

Doren Diagnostic Reading Test of Word Recognition Skills (Adapted to the Australian population) (Doren, 1973).

Schonell Graded Word Reading Test (R.I.) (Schonell, & Schonell, 1955)

1977 October/November/December. Grade 3

Stanford Diagnostic Reading Test Level I (Karlson, Madden, Gardner, 1966)

Schonell Graded Word Reading Test (R.I.) (Schonell, & Schonell, 1955)

1980 October/November/December. Grade 6

Stanford Diagnostic Reading Test Level II (Karlson, Madden, Gardner, 1966)

Schonell Graded Word Reading Test (R.I.) (Schonnel, & Schonnel, 1955)

TABLE 2

Six factors obtained from factor analysis of predictor variables[a]

PRDF I

Psycholinguistic Abilities. This factor was defined by the three subscales from the Illinois Test of Psycholinguistic Abilities (Grammatic Closure, Auditory Closure, and Sound Blending).

PRDF II

Figure Drawing. This factor was primarily defined by three tests from the Sheppard School Entry Screening Test that require pupils to copy single geometric patterns presented visually, to draw them from memory when given only components of them, and to draw a human figure. The Santucci copying Geometric Forms Test also loaded on this factor.

PRDF III

Language. This factor was primarily defined by items from the Sheppard Test that require pupils to repeat nonsense syllables, to distinguish between word pairs, to describe a story, to repeat a short paragraph/single words/sentence, and retell a story. The Bureau Auditory Comprehension Test (a measure of comprehension of spoken language) and the Auditory Attention Span for Related Syllables also had moderate loadings on this factor.

PRDF IV

Rhythm. This factor was defined by the Stambak Rhythm Test (a measure of the child's ability to reproduce a tapping pattern) and items from the Sheppard Test that measured the same ability.

PRDF V

Perceptual Motor. This factor was defined by items from the Sheppard Test requiring pupils to demonstrate proficiency in hopping, jumping, skipping, throwing and catching a ball, walking a beam, etc.

PRDF VI

Spatial/Form Perception. This factor was primarily defined by three of the four tests from the Frosting Developmental Test of Visual Perception (Position in Space, Eye Motor Coordination, and Spatial Relationships). The Santucci Copying Geometric Forms Test also loaded on this factor.

[a]The Letter Recognition Test had loadings on all the factors. The Figure-Ground score from the Frostig test did not load substantially on any of the factors.

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TABLE 3

Correlations Between Predictor Variables and Reading Criterion Scores Before and After (correlations in parentheses) Controlling for Initial IQ
(N=320 subjects for grades 1, 2, 3, N=286 for grade 6)

Predictor Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) Sex	-																
(2) Parent's Language	.04 (.01)	-															
(3) PRDF I	.03 (.11)	.45 (.12)	-														
(4) PRDF II	.02 (.04)	.18 (.06)	.23 (.09)	-													
(5) PRDF III	.07 (.13)	.34 (.04)	.41 (.04)	.16 (.02)	-												
(6) PRDF IV	.05 (.08)	.17 (-.04)	.41 (.23)	.41 (.36)	.38 (.22)	-											
(7) PRDF V	.10 (.13)	.16 (-.04)	.25 (.02)	.46 (.41)	.32 (.15)	.38 (.29)	-										
(8) PRDF VI	.00 (.02)	.28 (.08)	.31 (.04)	.55 (.51)	.21 (-.04)	.41 (.30)	.47 (.38)	-									
Actual Reading Scores																	
(9) Actual Reading Grade 1	.07 (.11)	.27 (.08)	.44 (.27)	.35 (.29)	.40 (.24)	.40 (.30)	.23 (.12)	.37 (.26)	-								
(10) Actual Reading Grade 2	.15 (.20)	.23 (.03)	.40 (.20)	.38 (.32)	.47 (.33)	.44 (.35)	.32 (.21)	.46 (.36)	.69 (.64)	-							
(11) Actual Reading Grade 3	.16 (.22)	.29 (.05)	.49 (.27)	.42 (.35)	.49 (.31)	.49 (.38)	.41 (.31)	.48 (.35)	.69 (.63)	.88 (.86)	-						
(12) Actual Reading Grade 6	.15 (.21)	.25 (.01)	.47 (.24)	.41 (.35)	.48 (.30)	.44 (.32)	.37 (.26)	.40 (.26)	.64 (.56)	.78 (.74)	.86 (.82)	-					
Predicted Reading Scores[a]																	
(13) Predicted Reading Grade 1	.12 (.24)	.46 (.13)	.76 (.54)	.60 (.41)	.68 (.48)	.69 (.64)	.39 (.23)	.64 (.54)	.58 (.48)	.45 (.54)	.68 (.56)	.68 (.52)	-				
(14) Predicted Reading Grade 2	.24 (.36)	.36 (.02)	.62 (.32)	.59 (.58)	.72 (.57)	.68 (.62)	.49 (.37)	.71 (.63)	.56 (.45)	.65 (.57)	.69 (.58)	.69 (.53)	.96 (.44)	-			
(15) Predicted Reading Grade 3	.23 (.38)	.41 (.06)	.70 (.44)	.59 (.60)	.69 (.51)	.69 (.64)	.59 (.52)	.68 (.60)	.56 (.45)	.65 (.55)	.70 (.60)	.70 (.54)	.97 (.43)	.98 (.97)	-		
(16) Predicted Reading Grade 6	.23 (.37)	.38 (.02)	.71 (.46)	.62 (.64)	.72 (.56)	.66 (.59)	.56 (.47)	.61 (.49)	.57 (.46)	.63 (.54)	.69 (.59)	.69 (.55)	.97 (.94)	.97 (.96)	.99 (.98)	-	
Control Variable																	
(17) IQ	-.07 (00)	.55 (00)	.69 (00)	.24 (00)	.57 (00)	.38 (00)	.34 (00)	.41 (00)	.38 (00)	.39 (00)	.46 (00)	.46 (00)	.41 (00)	.70 (00)	.64 (00)		

[a]Predicted Reading Scores are the reading scores that are predicted on the basis of the eight predictor variables. They were obtained with multiple regression as summarized in Table 4. For example, the multiple correlation between the set of predictor variables and actual reading in grade 3 is .70 (.60 after correcting for IQ).

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Table 4

Stepwise Multiple Regressions Used to Predict Reading in Each Grade

	Predictor Variables	Change in Mult R^2	Final Beta Weight	Mult R	Mult R^2
Grade 1	PRDF I	.20	.23**	.58	.34
	PRDF II	.06	.17**		
	PRDF III	.05	.22**		
	PRDF VI	.01	.15**		
	PRDF IV	.01	.12*		
	PRDF V	.01	-.10		
	Sex	.00	.05		
	Language	.00	-.01		
Grade 2	PRDF III	.22	.31**	.65	.42
	PRDF VI	.14	.26**		
	PRDF IV	.03	.13*		
	Sex	.02	.12*		
	PRDF I	.01	.13*		
	PRDF II	.01	.14*		
	PRDF V	.00	-.05		
	Language	.00	.04		
Grade 3	PRDF I	.24	.22**	.70	.49
	PRDF VI	.12	.20**		
	PRDF III	.08	.26**		
	PRDF II	.02	.13*		
	Sex	.02	.12*		
	PRDF IV	.01	.13*		
	PRDF V	.00	.06		
	Language	.00	.01		
Grade 6	PRDF III	.23	.29**	.66	.44
	PRDF II	.12	.20**		
	PRDF I	.06	.24**		
	Sex	.01	.11*		
	PRDF VI	.01	.11		
	PRDF IV	.01	.09		
	PRDF V	.00	.04		
	Language	.00	.03		
Grades 1-6	PRDF III	.25	.30**	.71	.50
	PRDF VI	.15	.23**		
	PRDF I	.04	.20**		
	PRDF II	.03	.16**		
	Sex	.02	.12*		
	PRDF IV	.01	.13*		
	Language	.00	.02		
	PRDF V	.00	-.01		

Table 5

Classification of Children as Being "At Risk" Based Upon Three Strategies: Hit Rate and Number of Target Population Correctly Classified

Strategy I - Comprehensive Testing of All Children

Target Population	Selection Criterion Bottom 5%	Bottom 10%	Bottom 15%	Bottom 20%
Bottom 5% (N = 16)	95% (8)	93% (12)	87% (12)	84% (14)
10% (N = 32)	92% (12)	91% (18)	89% (22)	85% (24)
15% (N = 48)	89% (14)	89% (22)	86% (26)	84% (31)
20% (N = 64)	84% (14)	86% (25)	84% (31)	82% (36)

Strategy II - Eliminating 50% of Sample on Basis of Letter Recognition Test and Comprehensive Testing of Remaining 50%

Target Population	Selection Criterion Bottom 5%	Bottom 10%	Bottom 15%	Bottom 20%
Bottom 5% (N = 16)	94% (6)	91% (9)	86% (9)	83% (11)
10% (N = 32)	91% (10)	89% (15)	87% (19)	83% (21)
15% (N = 48)	87% (12)	87% (19)	84% (23)	82% (28)
20% (N = 64)	82% (12)	84% (22)	82% (28)	81% (33)

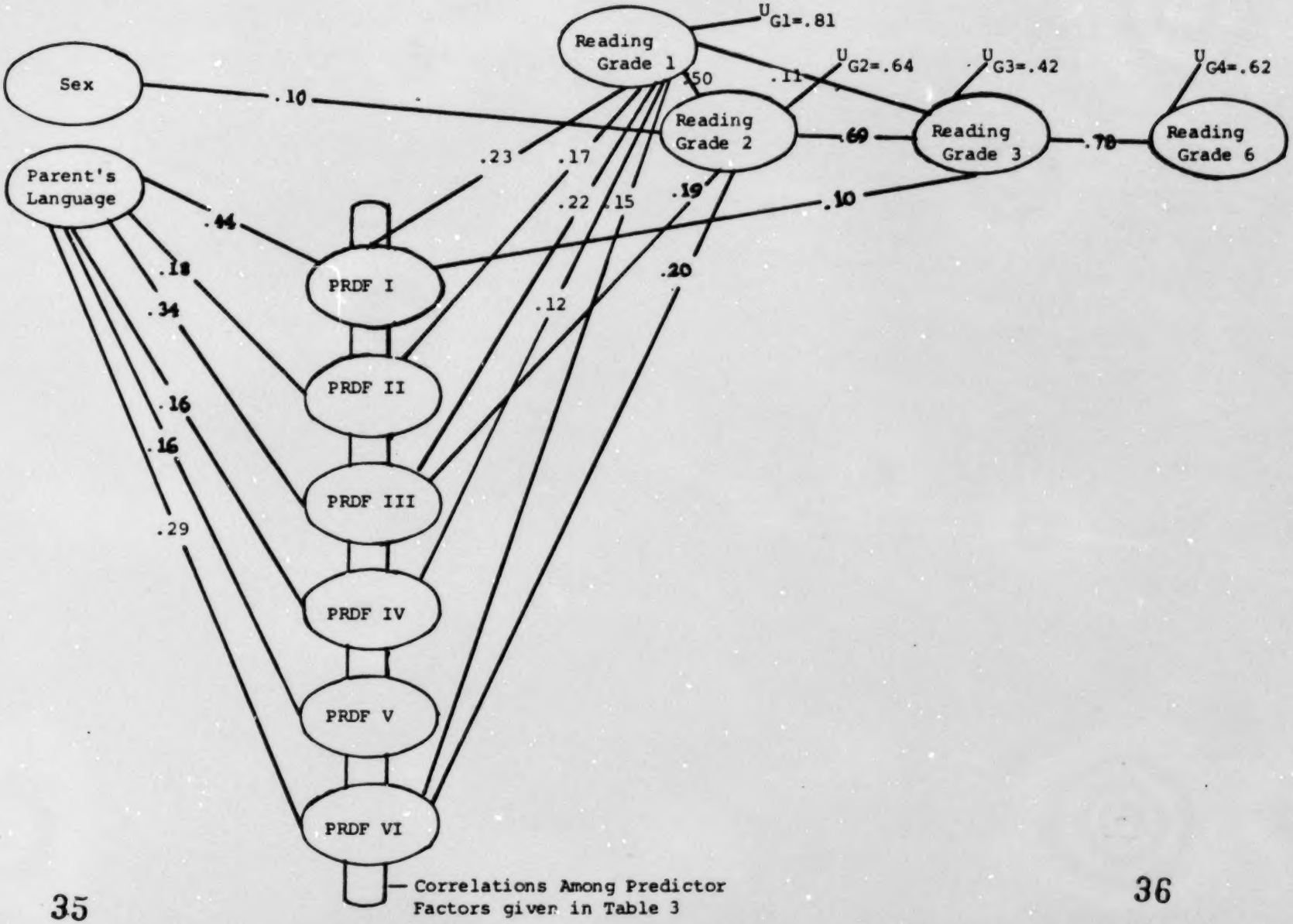
Strategy III - Elimination of 75% of Sample on Basis of Sheppard Test and Comprehensive Testing of Remaining 25%

Target Population	Selection Criterion Bottom 5%	Bottom 10%	Bottom 15%	Bottom 20%
Bottom 5% (N = 16)	95% (8)	93% (12)	87% (12)	84% (14)
10% (N = 32)	92% (12)	91% (18)	89% (22)	86% (24)
15% (N = 48)	89% (14)	89% (22)	86% (26)	84% (30)
20% (N = 64)	84% (14)	86% (25)	83% (29)	81% (33)

Note: The reading criterion was based upon the combined reading scores over grades 1, 2, 3, and 6. However, similar results were obtained when the analysis was based upon reading scores from just grade 6.

Figure Caption

Figure 1. A path-analytic model describing the relationship between the two background variables (Sex and Parent's Language), the six predictor factors (PRDF I - PRDF VI), and reading achievement in Grades 1, 2, 3, and 6.



Correlations Among Predictor Factors given in Table 3